FULL DEPTH PRECAST CONCRETE DECK PANEL MANUAL

Refer to Utah Department of Transportation (UDOT) Specification 03339 - Full Depth Concrete Deck Precast Panel

TABLE OF CONTENTS

Section 1

GENERAL INFORMATION

The purpose of this manual is to provide guidance with the design and detailing of Full Depth Precast Concrete Deck Panels using either mild or prestressed reinforcement in accordance with AASHTO LRFD Bridge Design Specifications except as noted otherwise.

The Precast (Prestressed) Concrete Panel details sheet will normally contain, but is not limited to, the following listed details:

- Plan View
- Typical Transverse Section
- Prestressing and/or Post-tensioning details
- Lifting details
- Transverse Joint Details
- Bar Details
- Table of Estimated Quantities

Nomenclature: The use of the terms ‘Longitudinally’ and ‘Transverse’ in this document and the guideline drawings will be in reference to the bridge direction unless otherwise noted. For example, on a typical multi-girder bridge, a longitudinal joint runs parallel to the direction of traffic, and a transverse joint runs perpendicular or at a skew to the direction of traffic.

Show the following dimensions on the Precast Prestressed Concrete Panel Details Sheet as listed below:

Structural dimensions and deflections. In the plan view, all structural dimensions in feet and inches to the nearest 1/8”. Deflections shown in the dead load deflection diagram in decimal feet to the nearest 0.01'. All other views and details in feet and inches to the nearest 1/8".

Reinforcing steel. Reinforcement dimensions and locations in all views, including bar details, will normally be in feet and inches to the nearest 1/4". All measurements are to the centerline of the reinforcements.

Cover. Cover for the top panel reinforcing is 2-1/2" clear cover after 1/4” maximum grinding allowance and bottom panel reinforcing is 1" clear cover. Transverse bars have 2" end cover and longitudinal bars have 2" end cover.

Angles. In degrees, minutes, seconds to the nearest whole second, if such precision is available.

References. *Designer will verify that all requirements of the current AASHTO LRFD Bridge Design Specifications and current interim provisions Sections 5 and*

9 are satisfied and properly detailed in any documents intended or provided for construction.

Section 2

PRECAST CONCRETE PANEL SHEETS

These sheets are included to provide an example of the drafting layout of a typical Precast Concrete Panel Sheet. See the various sections of this chapter for directions on drawing particular details.

Example – Precast Panel Sheet

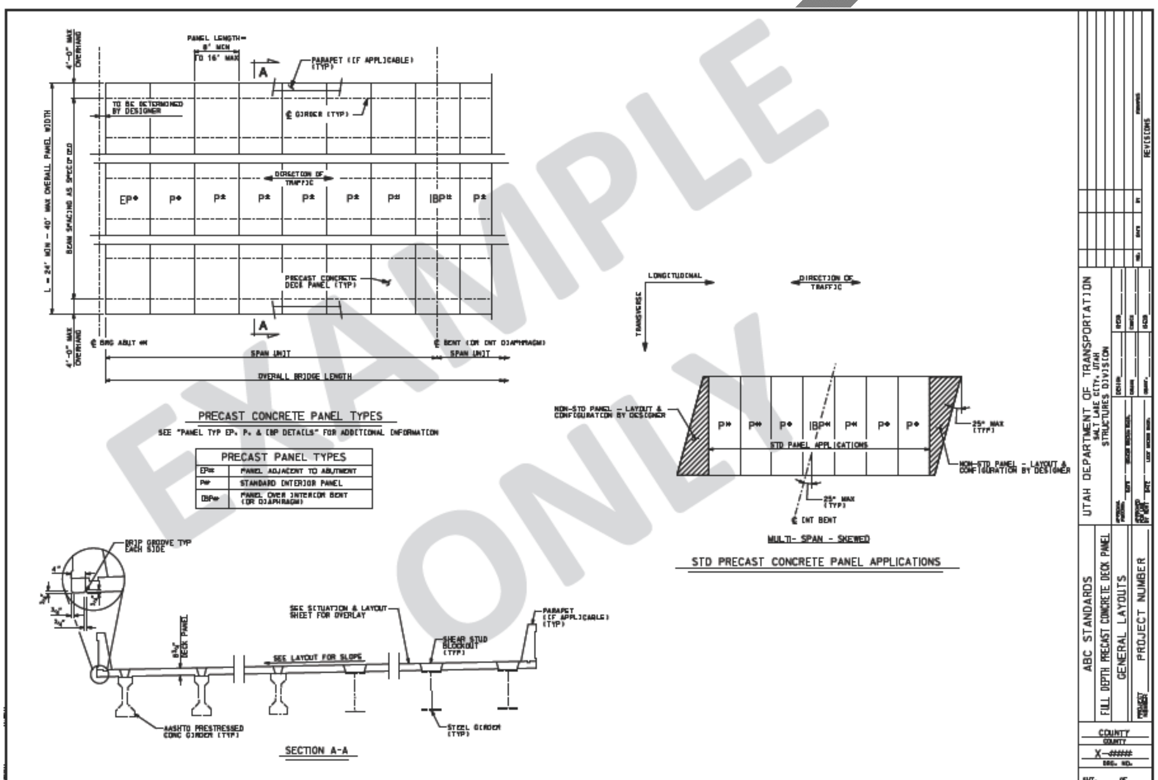

Figure 1 - Deck Panels on Concrete Beams

Section 3

SHEET CHECKLIST

Plan View
Accurate, measurable detail, with exceptions to enhance clarity

1. Label and locate the control line at transverse and skewed ends of panel (matching the terminology on the layout, such as reference line, centerline, or profile grade line).
2. Reference control dimensions at the working point (usually the intersection of the control line and the centerlines of bents and at the ends of the panel).
3. Overall panel length and individual span lengths dimensioned along the control line (and along panel edges if different).
4. Transverse widths of panel dimensioned, including overall, roadway, face of rail, curb, and median widths, and working point locations at the beginning of the panel.
5. Beam lines located and numbered.
6. Skew angles.
7. Label joint locations and type:
    a. Shear Keyway
    b. Longitudinal Post-Tensioning (LPT)
8. Panel reinforcing detailed, spacing dimensioned, and end cover shown.
9. Show abutment numbers and/or bent number.
10. Design Data.

Panel Grade Plan
Accurate, measurable detail, with exceptions to enhance clarity

1. Show all panel joints
2. Specify panel elevations at corners of all panels based on the as-erected condition. These elevations should account for the deflection of the beams under composite loads and the grade of the roadway surface.

Typical Transverse Section
Accurate, measurable detail, with exceptions to enhance clarity

1. Control line located both horizontally and vertically (note that more than one control line may be required).
2. Panel widths dimensioned (including overall, roadway, face of rail, offset from control line, etc.).
3. Show typical panel section reinforcing.
4. Reinforcing cover and panel thickness (interior and overhang).
5. Section depths (using table if required).
6. Beam spacing and identification.

7. Crown or roadway slope.
8. Spacing for reinforcement.
9. Spacing for longitudinal shear connectors.
10. Thin Bonded Polymer Overlay information or other approved overlay.
11. Future wearing surface information.
12. Post-tensioning shown for typical panel section.

Other Details
Accurate, measurable details, with exceptions to enhance clarity

1. Bar details, if applicable.
2. Joint details, if applicable.
3. Tendon confinement.
4. Parapet attachment.
5. Tables of quantities.
6. General notes (including, but not limited to, design criteria, loading, class of concrete, epoxy coating or galvanization, and cross references to various standard sheets).
7. Title block, information block, and Engineer's seal.

Final Checks
1. Comply with UDOT CADD Detailing Standards.
2. Check all details and dimensions against substructure to ensure the details are not in conflict.
3. Double check bars in various details against the bars shown in the bar table.
4. Make sure that bridge drains and/or bridge lighting brackets are located correctly on the layout, when applicable.
5. Ensure that the name and number of the bridge is same on all detail sheets (including layout).
6. Initial the sheet after back-checking corrected details.

Section 4

CONDITIONS AND ORIENTATIONS

Precast Concrete Panel Conditions and Orientations.

Use the full depth panels and details for bridge deck replacement, bridge widening, and new construction that adhere to the panel parameters below. For situations that fall outside of the limits and parameters shown below, the designer may use this manual, specifications, and standard drawings as guidelines for the design and detail Non-Standard Panels for job specific conditions.

Panel parameters are as follows:

- AASHTO HL-93 Loading
- 35-psf Future wearing surface, in addition to overlay
- 8-3/4” – normal minimum panel thickness to allow for 1/4" grinding thus creating an 8-1/2” nominal panel thickness
- 1/2" Thin Bonded Polymer Overlay
- Panel (Bridge) Transverse Width (See Figure 2)
    - 24’-0” Minimum
    - 40’-0” Maximum
- Panel Longitudinal Length (See Figure 2)
    - 8’-0” Minimum*
    - 16’-0” Maximum
- 1’-0” Minimum & 4’-0” - Maximum Overhang
    - Zero overhang is allowed for closure pours, 6" minimum bearing
- Up to 10’-0” – Beam Spacing for Precast Panels
- 8’-0” to 12’-0” – Beam Spacing for Prestressed Panels
- Minimum 4 lifting devices/locations per panel
- Minimum 2 leveling devices per beam/girder in each panel
- Skews up to 15 degrees with skewed panels
- Skews up to 45 degrees with square panels **

* Non-Standard Panels under 8’ will use only mild-reinforcement.
** End panels will be trapezoidal on heavily skewed decks

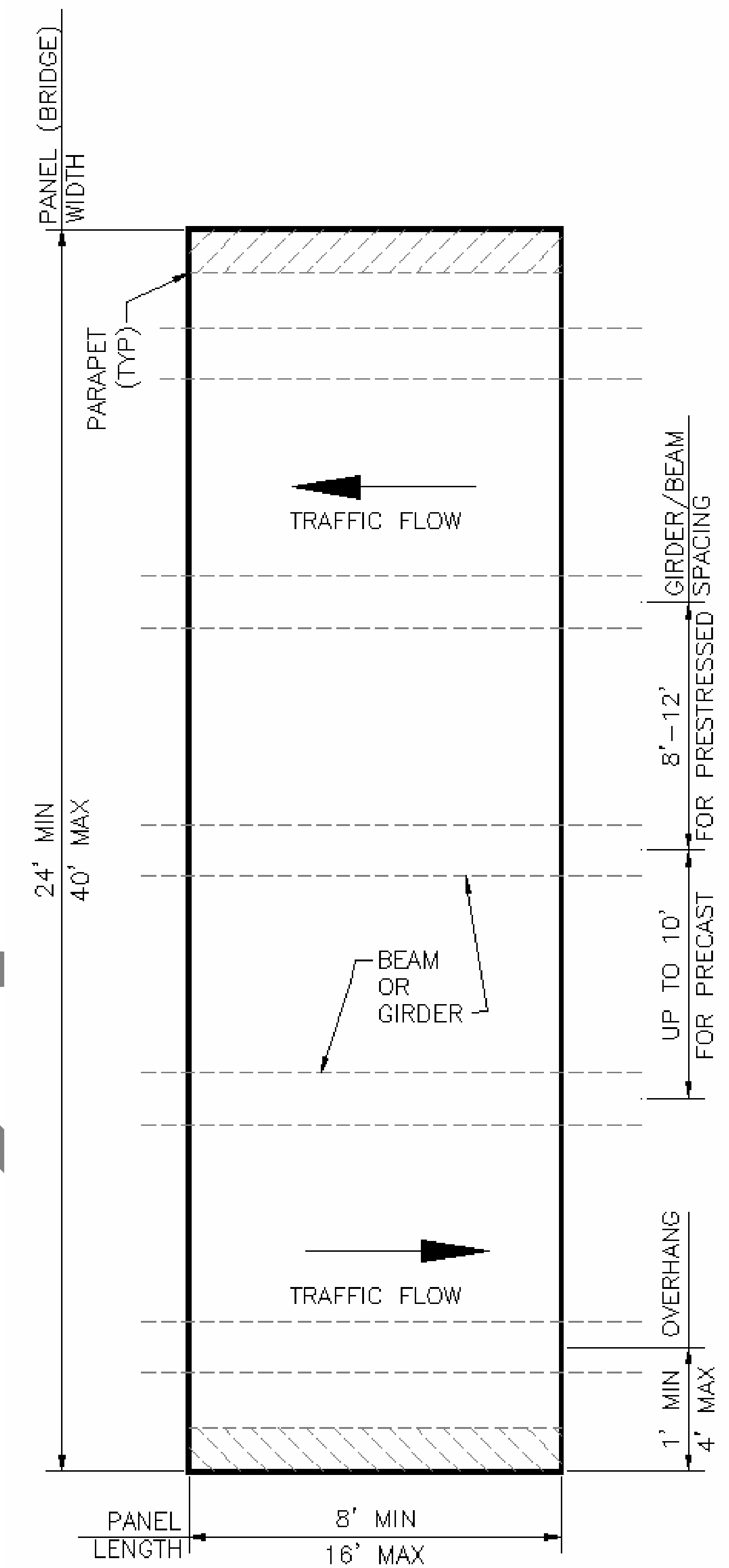

Figure 2 - Panel Dimensions

Skewed Bridges – Non-Standard Panels

This manual and associated specification and drawings serve as a guideline only for the design of the skewed panels. The full depth precast concrete deck panels are to be orthogonal to the supporting beams or girders. Designer will design and detail the resulting trapezoidal panel due to the bridge skew.

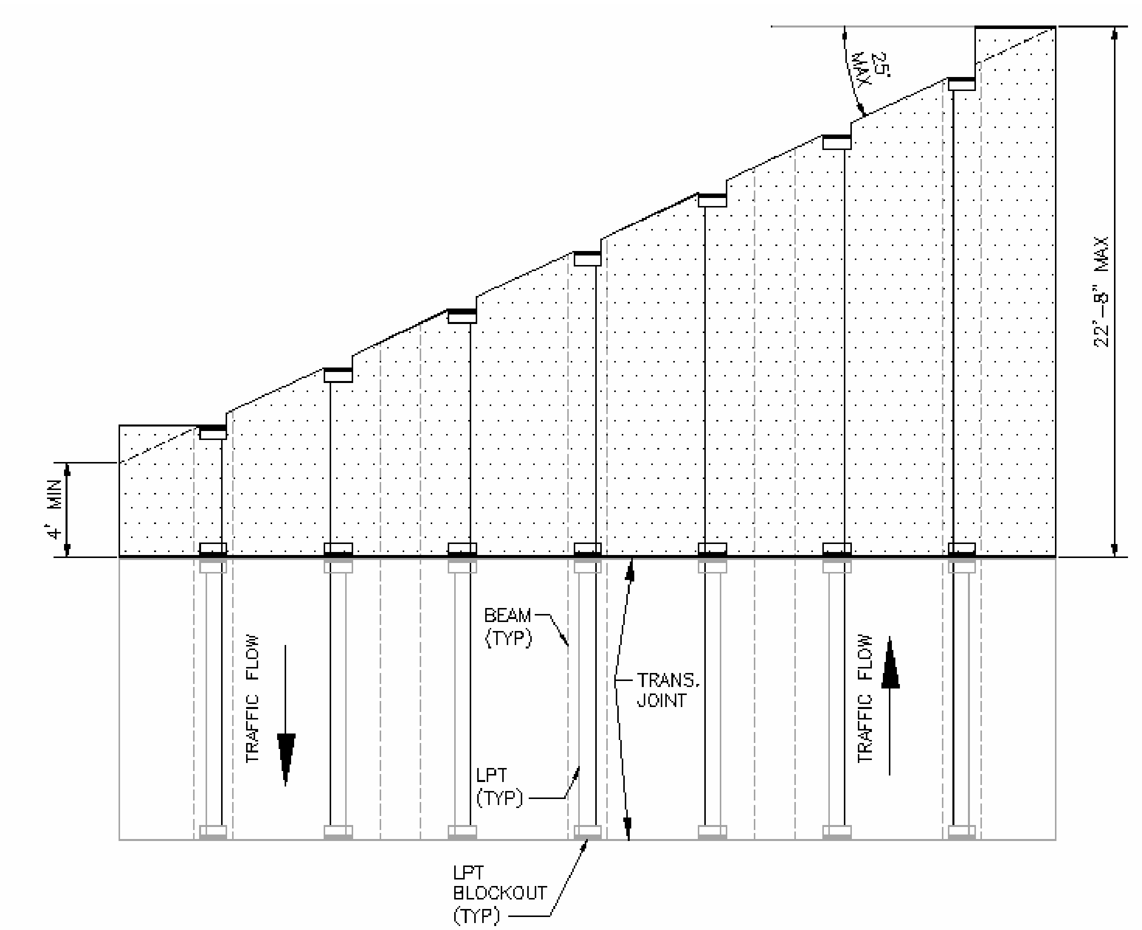

Figure 3 - Skewed Panel with LPT Joint Connection (Skews greater than 15 degrees)

Skewed panel parameters and limitations:

- The panel will have four sides as shown in plan with a minimum dimension of 4'-0".
- The maximum skew will be 45 degrees.
- The maximum weight of the panel will be 60 kips.
- Make longitudinal post tensioning blockouts parallel to strand and traffic.
- If the combination of end skew and bridge width produces panels that are excessively wide, the end panel can be made up of multiple panels with a longitudinal closure pour providing a connection.

Section 5

BEAM HAUNCH

Beam Haunch Details

The purpose of a beam haunch is to absorb the beam camber without intrusion of the beam into the bottom of the slab at centerline of bearing or at mid-span. This allows a uniform slab thickness. Use 1" minimum at the edge of the beam at midspan to accommodate the bedding strips for prestressed concrete panels, and to allow the free flow of grout. Regardless of calculated value, the absolute minimum haunch at centerline of bearing will be 1". (Increase in 1/4" increments).Reinforce haunch if the height of the beam haunch concrete is greater than 3".

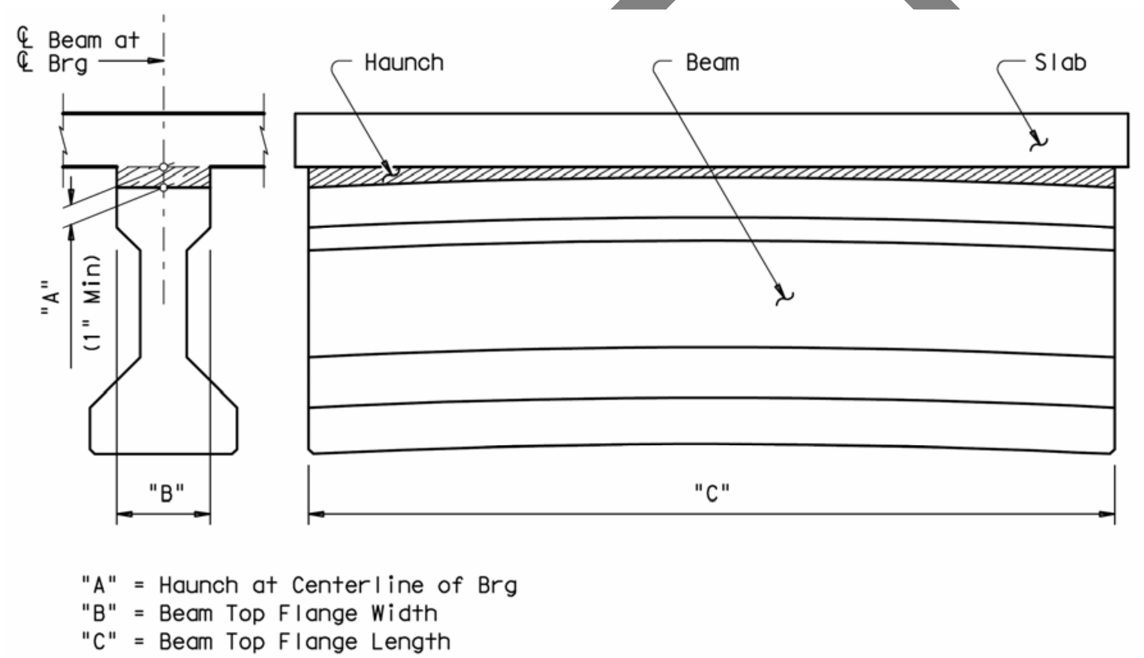

Figure 4 - Haunch Details

Section 6

TYPICAL MILD REINFORCING

Mild Reinforcement

Coat all mild reinforcement per UDOT Specification 03211 Reinforcing Steel and Welded Wire.

Reinforcement will not have lap splices within the panel. If splicing is required, specify and detail mechanical couplers on the plans. Couplers will develop a minimum of 125% of the minimum yield strength of the attached reinforcing bars. Use lap splices in closure pours but mechanical couples are encouraged. Do not weld reinforcement.

All top transverse reinforcement will have a standard 180-degree anchorage hook at each end.

Parapet Reinforcement

Designer will verify parapet reinforcement shown in the plans. Cast parapet connection reinforcement into panel.

The use of precast reinforcement mechanical couplers is acceptable provided the coupler meets AASHTO LRFD 5.5.3.4 Welded or Mechanical Splices of Reinforcement.

For parapet reinforcement, place in accordance with the plan, see the Parapet Details sheet. Do not drill and grout of parapet connection reinforcement into deck panel.

Precast Concrete Panel
Recommended Bar Sizes and Maximum Spacing

The information in this section shows typical precast concrete panel reinforcing and its placement. The reinforcement sizes, bends, and locations may be different from that given due to design requirements. Place all reinforcement in two layers. See standard drawings for reinforcement sizes and typical spacing.

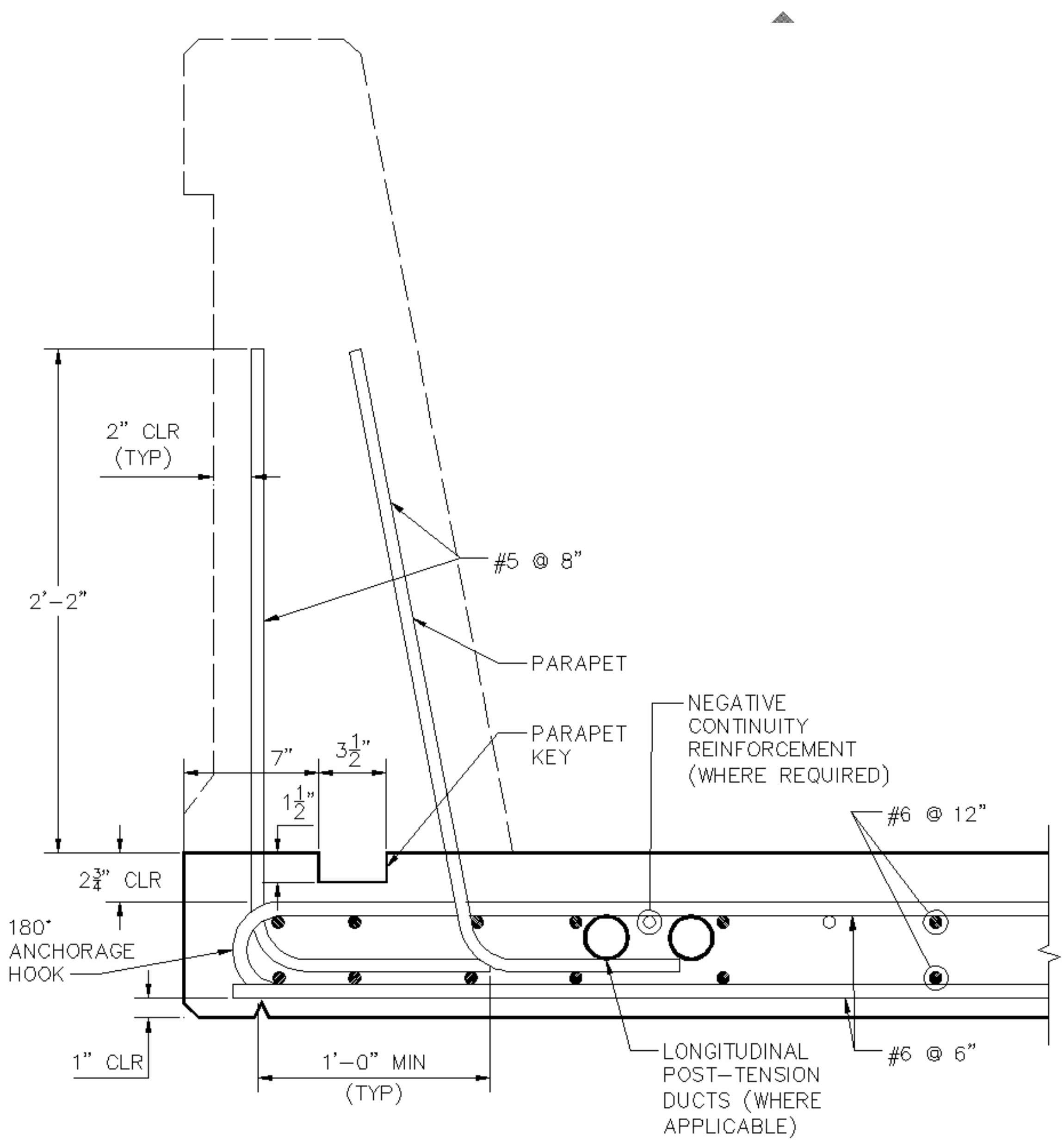

Figure 5 - Precast Panel Overhang Detail

Prestressed Concrete Panel
Recommended Bar Sizes and Maximum Spacing

The information in this section shows typical precast prestressed concrete panel reinforcing and its placement. The reinforcement sizes, bends, and locations may be different from that given due to design requirements. Place all reinforcement in two layers. See standard drawings for reinforcement sizes and typical spacing.

Contractor and manufacturer are responsible for verifying that provided reinforcement will suffice for proprietary systems.

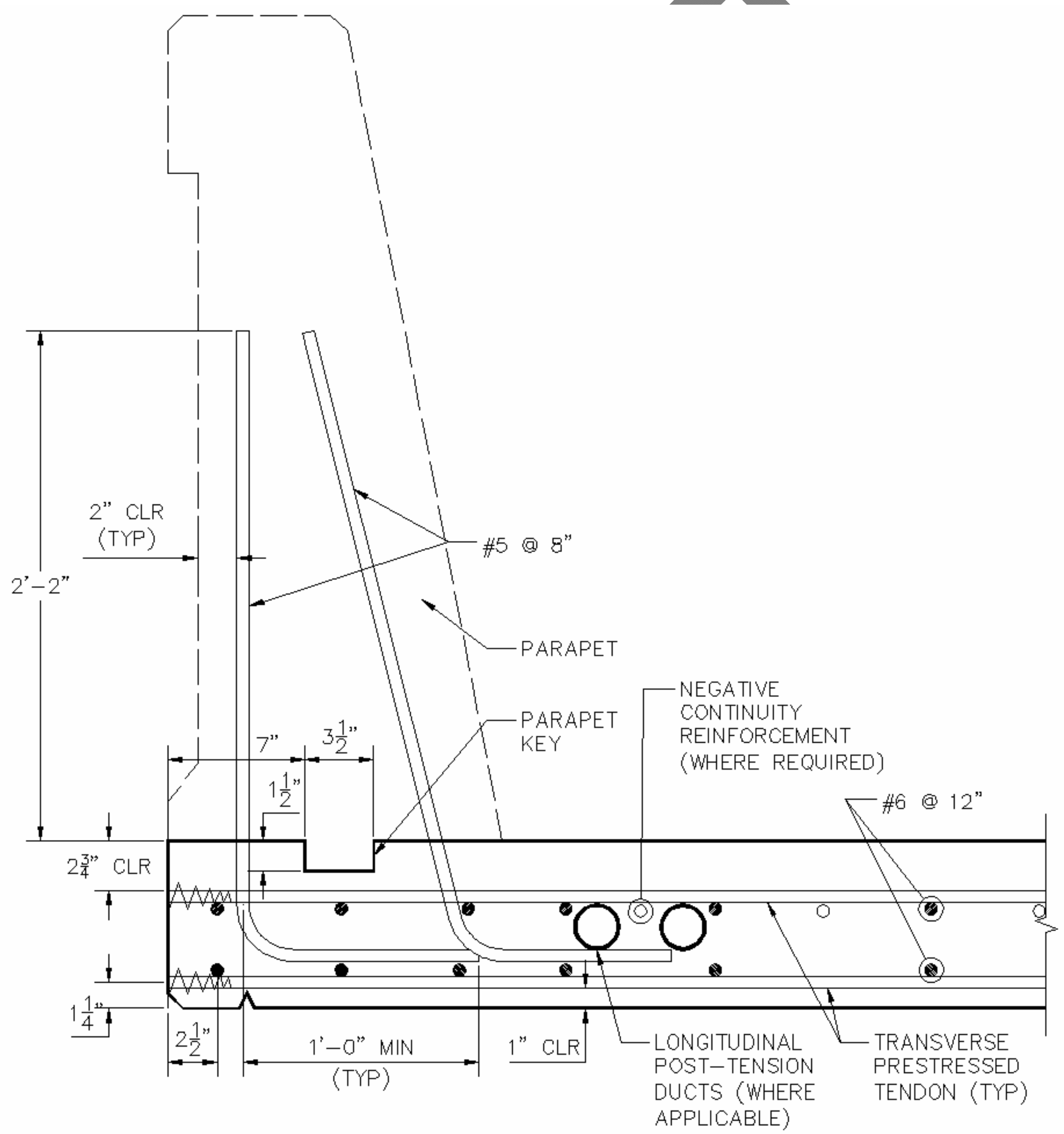

Figure 6 - Prestressed Panel

Section 7

HORIZONTAL SHEAR CONNECTION TO BEAMS / GIRDERS

Shear connections via blockouts

Design Engineer will determine shear connectors and spacing based on the design of the beams.

There are three acceptable methods to provide a shear connection to concrete beams:

1. Use stirrups projecting from the top of the beam
2. Use welded shear studs attached to a plate embedded in the top flange (anchored with cast-in welded shear studs).
3. T-Headed reinforcing bars placed in the top flange in a drilled and grouted hole.

Use a welded stud shear connector to make the connection to steel beams and girders.

Deck Replacement Projects

1. Concrete Beam Bridges
    a. Contractor will remove existing shear reinforcement without damaging the beam or girder and leave less than 1/2" material above top of flange.
    b. Only use T-Headed reinforcing bars placed in drilled and grouted holes.
2. Steel Beam and Girder Bridges
    a. Use welded shear studs.

New Construction Projects

1. Concrete Beam Bridges
    a. All three methods listed above are acceptable for new construction.
2. Steel Beam Bridges
    a. Use welded shear studs.

Details for T-Headed reinforcing bars installed on concrete beams

- T-headed reinforcing bars may be cast into the beam or drilled and grouted in place after beam casting
- Use #6 reinforcement or equivalent.
- Head size will be designed to fully develop bar.
- Bar will be embedded into concrete beam at least 6-5/8" and provide at least 26.4 kips in tension.
- Contractor will use an approved anchorage epoxy and follow all of the recommendations of the epoxy manufacturer.

Details for Welded Shear Stud Connectors

- Shear connectors will be at least 3/4” in diameter.
- Length of required shaft will be determined by two factors:
    - The bottom of head of the connector will be at or above mid-height of panel but will maintain 3” of clear cover.
    - Length will be at least four times the diameter.
- Attach the connector to the steel flange by an approved method (resistance welding is the most common method used).
- Testing of shear connectors will be by approved methods and verified prior to placement of panels.

Section 8

LIFTING DEVICES, HANDLING, AND STORAGE

Lifting devices

The plans will show recommended lifting locations based on the panel design. The engineer is responsible for checking the handling stresses in the panels for the lifting locations shown on the plans. The following general criteria should be followed for designing the panels:

- Use four point picks for most panel configurations. If four point pick is used, assume that only two diagonal lift points are engaged at any one time.
- If panel stresses are excessive with a four point pick, an eight point pick may be used. Notes should be added to the plans requiring the use specialized rigging that includes pulleys.
- A dynamic load allowance of 15 percent should be used.
- The engineer should not show specific lifting hardware on the drawings. The engineer should verify that at least one lifting hardware manufacturer can provide a device that can resist the anticipated loads. If no manufacturer can meet the required resistance, the engineer should consider reducing the size of the panel, or switch to a more sophisticated lifting system. The engineer should consult with fabricators for these situations.
- Specify that any lifting hardware left in place must have 2½" top cover and 1" bottom cover after installation.

The Contractor may choose alternate lifting locations with approval from the engineer. The Contractor will provide the spacing and location of the lifting devices and submit plan and handling stress calculations to the Engineer for approval prior to construction of panel. See Specification 03339 for Handling Stress Requirements.

Place lifting devices no closer that 2'-0" from the edge of the panels.

Place additional reinforcement on each side of the lifting device and in each direction of the panel to distribute the load. Place the additional reinforcement below the first layer of panel reinforcement. The lifting device will have positive connection to this additional reinforcement.

Lifting devices will be removable below the top surface of the panel after placement. Any divot or void at the lifting devices will have a heavy broom finish. After placement of panel in final position, fill divots or voids in with structural non-shrink grout. Place grout high and ground to final elevation.

Handling and Storage

Contractor is responsible for the handling and storage of panels in such a manner that does not cause undue stress on the panel. Submit a handling and storage plan to the Engineer for review prior to the construction of any panel.

The Engineer will inspect all panels and reject any defective panel. Replace any rejected panel at the contractor's expense. Contractor will be responsible for any schedule delays due to rejected panels.

The following general criteria will be cause for rejection:

- Broken corners that cannot be properly repaired (in the opinion of the Engineer).
- Full depth cracking in a prestressed panel.
- Significant dimensional deformities
- Panels that are fabricated outside of the specified tolerances

See Specification 03339 for Handling and Storage.

Section 9

VERTICAL ADJUSTMENT

Vertical Adjustment Devices

Use vertical adjustment devices to provide:

- Adjustment of grade to meet the elevations shown on the panel grade plans
- Proper dead load distribution to the beams

The plans show a typical device; however the plans should note that alternate devices may be used with approval from the engineer.

Devices will be pre-adjusted to approximate required final elevation for panel.

There will be at least two devices per panel along each girder.

During installation, all devices must be in full contact with the beams. Specify that the torque of each adjustment device be adjusted to within 15 percent of the average torque on each device. This will achieve a reasonable distribution of panel dead load.

Each adjustment device will have a capacity of at least 100% more than the tributary weight on the devicel.

The methods for grouting the shear connector pockets and the beam haunch are highly dependent on the grout mix chosen. A mock-up of the beam haunch and shear connector pocket should be specified so that a test pour can be run prior to the construction of the actual deck. The mock-up should contain at least two shear connector pockets. The mock-up requirement can be waived if the Contractor can demonstrate that successful grout pours have been completed on similar projects with the same grout. Place the non-shrink grout high and ground to final elevation.

Designer will verify the type of device used and the locations of the devices. Show device locations on the plans.

Section 10

TRANSVERSE JOINT SHEAR CONNECTIONS

Shear Transfer at Transverse Joint

Grout the transverse joint components, block-outs, and post-tensioning ducts with a non-shrink grout having a minimum compressive strength of 5.0 ksi at 24 hours.

Rod grout in place during installation to consolidate theh grout and prevent voids. All grout will be poured high and ground to elevation to prevent low areas.

Typically, for ease of fabrication, select panels with mild reinforcement for narrow girder spacing under 10’. Select prestressed panels for beam spacing greater than 10'. Furthermore, the prestressed panels may prove to be more durable and may be more economical in the long term. For expected life spans of 15 years and greater, the prestressed panel should be selected.

A transverse joint between the panels will create a maintenance point. The longitudinally post-tensioned panel is the only connection allowed as it provides compression at the joint that helps resist cracking and water infiltration at the joint.

TRANSVERSE JOINT SHEAR CONNECTIONS (cont.)

Longitudinal Post-Tensioning (LPT)

Panels made flexurally continuous by longitudinal post-tensioning are the preferred transverse joint detail because they behave more monolithically and require less maintenance on the long-term basis. Use LPT on all bridges. The design of the longitudinal post tensioning shall conform to the AASHTO LRFD Bridge Design Specifications. The following criteria should be followed:

1. add information from spreadsheet

Provide hand hole block-outs at all joints to permit the splicing of post-tensioning ducts. The blockout should be approximately 6”x6” in plan.

The LPT system shall be specifically designed for concrete deck systems. The following systems are acceptable for use:

1. DSI Flat Anchorage Type FA (4-0.5” strand)
2. VSL Stressing Anchorage Type SA5-4 (4-0.5” strand)

Other systems may be used provided that the anchorage assembly can be fit within the deck with the proper concrete cover.

In order to facilitate strand placement, the maximum size of strand should not be used for a particular duct. This is based on the possibility of duct friction brought on by the large number of duct splices in the system. For example, if a duct manufacturer allows 4-0.6” strand in a particular duct, the design should be based on 4-0.5” strand. The following ducts are recommended for use:

1. DSI Flat PE/PP (inside dimensions 1.14” x 3.15”)
2. VSL Plastic Duct PT-PLUS™ 5-4 (inside dimensions 0.83” x 2.83”)

A strict sequence of construction is required for LPT systems. The following general sequence must be followed:

1. Place panels on the beams without mortar or adhesives in the proper horizontal position.
2. Adjust panel grades to the specified elevations using the vertical adjusting devices
3. Install post-tensioning strand in ducts loose. Seal duct splices.
4. Place grout in transverse shear keys
5. When grout has attained a strength of 500 psi (based on manufacturer’s recommendations), stress post-tensioning to specified levels.
6. Grout post tensioning ducts.
7. Form beam haunch (note that this may be done at any time after step 2).
8. Install grout in beam haunch and shear connector blockouts

Section 11

TRANSVERSE PRESTRESSING

Materials

Concrete

- f'_{ci} = 4,000 psi
- f'_c = 5,000 psi

Prestressing Strand

- Low relaxation strand
- f_u = 270 ksi
- d_{ps} = 0.5 in
- A = 0.153 in^2

Designer may select a precast panel or prestressed panel when the spacing of the beams or girders is between 8' and 10'. When the spacing is greater than 10', the designer will use a prestressed panel. The prestressed panel should provide a more durable structure, since shrinkage cracking will be minimized or eliminated. The designer should consider life span of structure and bridge configuration when selecting panel type. If life expectancy is greater than 25 years, give strong consideration to this option.

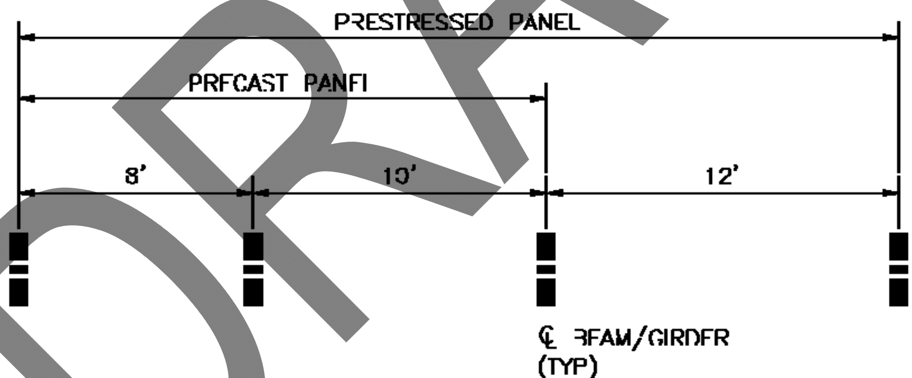

Figure 7 - Beam Spacing Panel Selection

The Prestressed Concrete Panel will be of nominal thickness with strands placed transversely and approximately level at a maximum spacing of 1'-0". Place each strand as close to the extreme fiber as the clear cover will allow.

Designer will verify any required local anchorage or confinement mild reinforcement.

Section 12

PANEL TOLERANCES

The tolerance of casting panels is critical to a successful installation. If the overall panel dimensions vary, the length of the bridge deck will vary from the specified limits. If the edges of the panels are not straight, the panels will not nest properly, thereby causing the panel spacing to increase.

One of the most important tolerances is the location of the post-tensioning ducts. Variation on duct locations will lead to unacceptable misalignments at the duct splice locations. These misalignments will make it difficult to push the strand through the duct and cause large friction between the duct and the strand.

In order to properly specify tolerances of critical elements, the tolerance measurements must be made from a common working point or line. Center to center measurements can lead to a build-up of tolerance errors.

The deck panel standards include a detail of recommended tolerances. This detail must be included in all deck panel projects.

Section 13

THIN BONDED POLYMER OVERLAY

Materials

Thin Bonded Polymer Overlay will conform to Section 03372, Thin Bonded Polymer Overlay. Only use Epoxy-Urethane Co-Polymer, Type 1.

Application

All surfaces that are to receive an overlay will have a heavy broom finish.

Apply the overlay to the panel surface after the surface has been prepared to the manufacture’s recommendation.

The designer will select an overlay thickness equal to or greater than 1/2" to increase durability and lifespan of panel, to resist the deicing chemicals, and reduce the amount of water infiltration into the weak transverse joint.

At minimum, apply the overlay in at least two coats to obtain the minimum required thickness.

Joints of the overlay will not coincide with the joints of the deck panels.

Section 14

CLOSURE POURS

General

Closure pours may be used where needed as directed, designed, and detailed by the designer. Concrete compressive strength will be of at least 4000 psi and will include a corrosion inhibitor. Provided details are for beam spacing up to 10'. Designer will design and detail closure pours for beam spacing larger beam spacing.

Cast-in-place closure pours tend to behave differently then precast or prestressed panels. This is due to multiple factors. The panels will typically have better casting environments and more controlled conditions of a cast-in-place structure. Designer should specify wet curing for at least 7 days to increase the durability of the closure pours. The concrete for closure pours should be XXXXX.

When required, use mechanical couplers in conjunction with the continuous panel reinforcement to provide continuous reinforcement in closure pours. All mechanical couplers will conform to AASHTO 5.11.5.2.2 and ACI 318 12.15.3 and meet UDOT requirements. If used, precast the couplers into the panel after securely attaching them to the continuous reinforcement.

Lap splices of continuous panel reinforcement made in a closure pour will be a minimum of 3'-1".

When girder spacing exceeds 7'-0", contractor will supply full-length temporary support to the panel overhang and closure pour until closure pour has gained full compressive strength.

Closures at Transverse Joint

The designer will include an 'edge beam' parallel to the transverse joint which will include at least three (3) #6, top and bottom, spaced at 3" for the full length of the transverse joint. Lap splices will be staggered so that no lap is adjacent, above, or below another lap splice. See Section A-A of Precast Panel Reinforcement Sheet for details.

Bridge Widening or Partial Deck Replacement

Contractor will cut back the existing deck to the next available beam or girders, leaving enough of the existing reinforcing to provide proper lap splices from the panel, clean the reinforcement, and repair any damaged coating per UDOT specifications.

The panel will cover at least two full bays, be in full contact and provide shear connections at least two beams or girders, and have bearing on a third beam or girder.

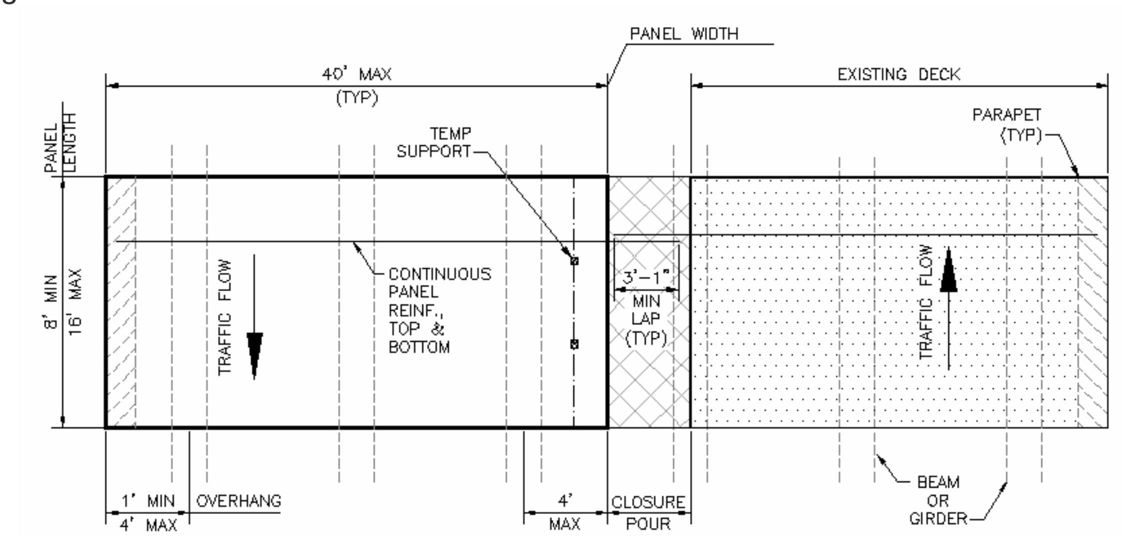

Figure 8 - Deck Widening or Partial Deck Replacement

Bridge Deck Wider than 40'-0"

If a panel is not wide enough for an entire bridge width, greater than 40'-0", use at least two panels with a longitudinal closure pour between. The closure pour will occur within the bay of the beams or girders. All panels will have a minimum of 1'-0" overhang with the exception of a closure pour location.

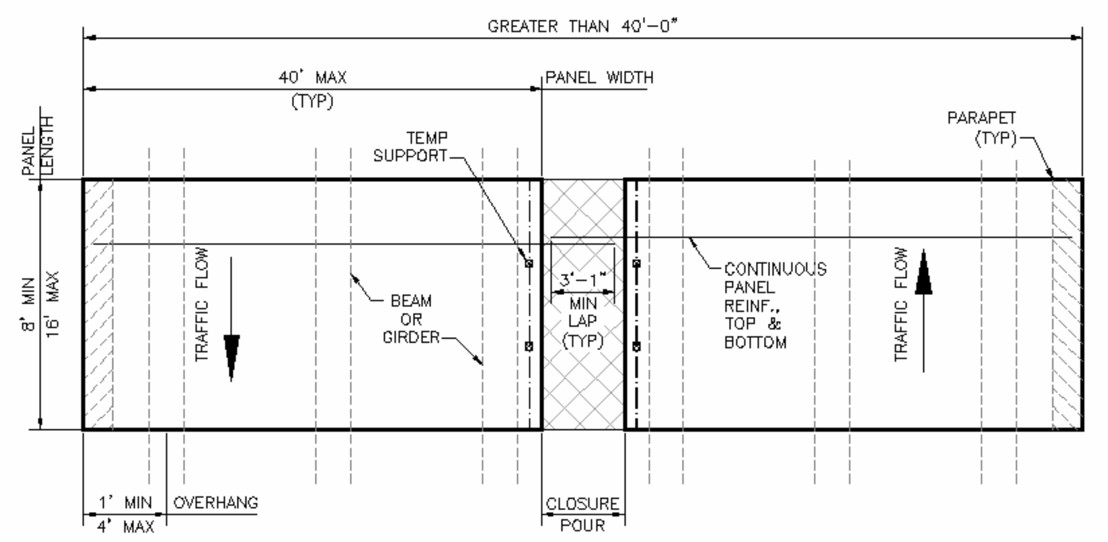

Figure 9 - Panel-to-Panel w/ Closure Pour